

Practitioner's Docket No. 5491

## CHAPTER II

TRANSMITTAL LETTER  
TO THE UNITED STATES ELECTED OFFICE (EO/US)

## (ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/SE98/01658	16 September 1998	17 September 1997
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
EXTERIOR AUTOBODY PART OF REINFORCED PLASTIC, AND ARRANGEMENT AND		
TITLE OF INVENTION		
METHOD FOR ITS FORMING		
APPLICANT(S)		
Arne Persson, Ake Nylander, Krister Svensson and Axel Kaufmann		

Box PCT

Assistant Commissioner for Patents  
Washington D.C. 20231

## ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

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**CERTIFICATION UNDER 37 C.F.R. § 1.10\***  
 (Express Mail label number is mandatory.)  
 (Express Mail certification is optional.)

I hereby certify that this Transmittal Letter and the papers indicated as being transmitted therewith is being deposited with the United States Postal Service on this date 16 March 2000, in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL470056081US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Tracy O. Higgins  
 (type or print name of person mailing paper)

Tracy O. Higgins  
 Signature of person mailing paper

**WARNING:** Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

**\*WARNING:** Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

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**WARNING:** Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. § 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. § 1.8).

**NOTE:** Documents and fees must be clearly identified as a submission to enter the national state under 35 U.S.C. § 371 otherwise the submission will be considered as being made under 35 U.S.C. § 111, 37 C.F.R. § 1.494(f).

- I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. § 371:
  - a.  This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).
  - b.  The U.S. National Fee (35 U.S.C. § 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

SEARCHED  INDEXED  SERIALIZED  FILED

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2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
<input checked="" type="checkbox"/>	<b>TOTAL CLAIMS</b>	11 -20=	0	× \$22.00=	\$
	<b>INDEPENDENT CLAIMS</b>	1 -3=	0	× \$82.00=	
	<b>MULTIPLE DEPENDENT CLAIM(S) (if applicable)</b>			+ \$270.00	
<b>BASIC FEE**</b>	<input type="checkbox"/> <b>U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY</b> Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: <ul style="list-style-type: none"> <li><input type="checkbox"/> and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... \$98.00</li> <li><input type="checkbox"/> and the above requirements are not met (37 CFR 1.492(a)(1)) ..... \$720.00</li> </ul> <input checked="" type="checkbox"/> <b>U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY</b> Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: <ul style="list-style-type: none"> <li><input type="checkbox"/> has been paid (37 CFR 1.492(a)(2)) ..... \$790.00</li> <li><input checked="" type="checkbox"/> has not been paid (37 CFR 1.492(a)(3)) ..... \$1,070.00</li> <li><input type="checkbox"/> where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) ..... \$930.00</li> </ul>				
	<b>Total of above Calculations</b>			= \$ 970.00	
<b>SMALL ENTITY</b>	<b>Reduction by 1/2 for filing by small entity, if applicable. Affidavit must be filed also. (note 37 CFR 1.9, 1.27, 1.28)</b>			-	
				<b>Subtotal</b>	<b>\$970.00</b>
				<b>Total National Fee</b>	<b>\$970.00</b>
	<b>Fee for recording the enclosed assignment document \$40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".</b>				
<b>TOTAL</b>				<b>Total Fees enclosed</b>	<b>\$970.00</b>

(Transmittal Letter to the United States Elected Office (EO/US) [13-18]—page 3 of 8)

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\*See attached Preliminary Amendment Reducing the Number of Claims.

- i.  A check in the amount of \$970 to cover the above fees is enclosed.
- ii.  Please charge Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_.  
A duplicate copy of this sheet is enclosed.

\*\*WARNING: "To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: \*\*\* (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).

WARNING: If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.

3.  A copy of the International application as filed (35 U.S.C. § 371(c)(2)):

NOTE: Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.

- a.  is transmitted herewith.
- b.  is not required, as the application was filed with the United States Receiving Office.
- c.  has been transmitted
  - i.  by the International Bureau.  
Date of mailing of the application (from form PCT/1B/308): 25 March 1999
  - ii.  by applicant on \_\_\_\_\_  
Date

4.  A translation of the International application into the English language (35 U.S.C. § 371(c)(2)):
  - a.  is transmitted herewith.
  - b.  is not required as the application was filed in English.
  - c.  was previously transmitted by applicant on \_\_\_\_\_  
Date
  - d.  will follow.

5.  Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)):

**NOTE:** *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.*

- a.  are transmitted herewith.
- b.  have been transmitted
  - i.  by the International Bureau.  
Date of mailing of the amendment (from form PCT/1B/308): \_\_\_\_\_
  - ii.  by applicant on (date) \_\_\_\_\_  
Date \_\_\_\_\_
- c.  have not been transmitted as
  - i.  applicant chose not to make amendments under PCT Article 19.  
Date of mailing of Search Report (from form PCT/ISA/210.): 11 December 1998
  - ii.  the time limit for the submission of amendments has not yet expired.  
The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6.  A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. § 371(c)(3)):

- a.  is transmitted herewith.
- b.  is not required as the amendments were made in the English language.
- c.  has not been transmitted for reasons indicated at point 5(c) above.

7.  A copy of the international examination report (PCT/IPEA/409)

- is transmitted herewith.
- is not required as the application was filed with the United States Receiving Office.

8.  Annex(es) to the international preliminary examination report

- a.  is/are transmitted herewith.
- b.  is/are not required as the application was filed with the United States Receiving Office.

9.  A translation of the annexes to the international preliminary examination report

- a.  is transmitted herewith.
- b.  is not required as the annexes are in the English language.

10.  An oath or declaration of the inventor (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115

- was previously submitted by applicant on \_\_\_\_\_ Date
- is submitted herewith, and such oath or declaration
  - is attached to the application.
  - identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. § 1.70.
  - will follow.

II. Other document(s) or information included:

11.  An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

- is transmitted herewith.
- has been transmitted by the International Bureau.  
Date of mailing (from form PCT/IB/308): \_\_\_\_\_
- is not required, as the application was searched by the United States International Searching Authority.
- will be transmitted promptly upon request.
- has been submitted by applicant on \_\_\_\_\_ Date

12.  An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98:

- is transmitted herewith.  
Also transmitted herewith is/are:  
 Form PTO-1449 (PTO/SB/08A and 08B).  
 Copies of citations listed.
- will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. § 371(c).
- was previously submitted by applicant on \_\_\_\_\_ Date

13.  An assignment document is transmitted herewith for recording.

A separate  "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or  FORM PTO 1595 is also attached.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

14.  Additional documents:

- a.  Copy of request (PCT/RO/101)
- b.  International Publication No. WO 99/14101
  - i.  Specification, claims and drawing
  - ii.  Front page only
- c.  Preliminary amendment (37 C.F.R. § 1.121)
- d.  Other  
PCT/IB/308; PCT/IB/332; PCT/IPEA/416

15.  The above checked items are being transmitted

- a.  before 30 months from any claimed priority date.
- b.  after 30 months.

16.  Certain requirements under 35 U.S.C. § 371 were previously submitted by the applicant on \_\_\_\_\_, namely:

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### **AUTHORIZATION TO CHARGE ADDITIONAL FEES**

**WARNING:** Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.

**NOTE:** "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

**NOTE:** "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 19-0079.

37 C.F.R. § 1.492(a)(1), (2), (3), and (4) (filing fees)

**WARNING:** Because failure to pay the national fee within 30 months without extension (37 CFR § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.

37 C.F.R. § 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

37 C.F.R. § 1.17 (application processing fees)  
 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a)).  
 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).



**SIGNATURE OF PRACTITIONER**

Reg. No.: 33,298

MATTHEW E. CONNORS

Tel. No.: (617) 426-9180  
Extension 112

(type or print name of practitioner)

Samuels, Gauthier & Stevens  
225 Franklin Street, Suite 3300

Customer No.:

P.O. Address

Boston, MA 02110

179/01406 A01

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Benny PESACH  
Serial Number: Not yet assigned  
Filed: September 9, 1998 as PCT/IL98/00435  
For: THREE DIMENSIONAL DEPTH ILLUSION DISPLAY  
Art Unit: Not yet assigned

Honorable Commissioner of Patents and Trademarks  
Washington DC 20231

**PRELIMINARY AMENDMENT**

Sir:

Further to the concurrent filing of a US national stage application of PCT application PCT/IL98/00435, kindly amend the application as follows:

**IN THE SPECIFICATION**

Kindly add the following on page 1, after the title:

**--RELATED APPLICATIONS**

This application is a US national filing of PCT Application PCT/IL98/00435, filed September 9, 1998, which claims priority from Israel Patent Application No. 121760, filed September 14, 1997. --

**IN THE CLAIMS**

Claim 3, line 1, kindly replace "any of the previous claims" with -- claim 1 --.

Claim 4, line 2, kindly delete "or claim 2".

Claim 11, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--.

Claim 12, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 13, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 14, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 15, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 16, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 17, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 18, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 19, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 20, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 21, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 22, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

Claim 23, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--  
Claim 24, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--  
Claim 25, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--  
Claim 26, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--  
Claim 27, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--  
Claim 28, line 1, change "any one of claims 1 or 5 - 10" to --claim 1--

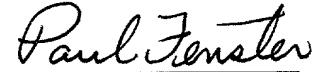
**REMARKS**

The present application is a U.S. National application of PCT application PCT/IL98/00435 filed September 9, 1998. The present amendment is based on the claims attached to the IPER dated February 14, 2000. After amendment the application includes claims 1-29. Claims 3-4 and 11-28 have been amended. The claims have been amended to cancel multiple dependencies.

The Examiner is respectfully requested to review and cite the art cited in the search report attached to WO 99/14725, the publication of PCT application PCT/IL98/00435. A filled-in Form 1449 is submitted herewith to facilitate this citation. The examiner has been supplied a copy of the art by WIPO.

All the claims have been allowed in the IPER. A notice of allowance is respectfully requested.

Respectfully submitted,  
B. PESACH



Paul Fenster  
Reg. No. 33,877

March 12, 2000  
Roy N. Envall, Jr.  
c/o Anthony Castorina  
2001 Jefferson Davis Highway  
Arlington, VA 22202  
Tel: (703) 415-1581

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR**

 Docket No.  
179/01406

Serial No. US Nat'l of PCT/IL98/00435	Filing Date Herewith	Patent No.	Issue Date
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 Applicant/ **Benny PESACH**  
Patentee:

 Invention: **THREE DIMENSIONAL DEPTH ILLUSION DISPLAY**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- the specification to be filed herewith.
- the application identified above.
- the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- No such person, concern or organization exists.
- Each such person, concern or organization is listed below.

\*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME Holomedia Technologies, Ltd.  
ADDRESS 20 Hameretz Street, Petach-Tikva 49517, Israel

Individual  Small Business Concern  Nonprofit Organization

FULL NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_

Individual  Small Business Concern  Nonprofit Organization

FULL NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_

Individual  Small Business Concern  Nonprofit Organization

FULL NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_

Individual  Small Business Concern  Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Benny PESACH

SIGNATURE OF INVENTOR Benny Pesach

DATE: 3/11/00

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

NAME OF INVENTOR \_\_\_\_\_

DATE: \_\_\_\_\_

SIGNATURE OF INVENTOR \_\_\_\_\_

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN**

Docket No.  
179/01406

Serial No.	Filing Date	Patent No.	Issue Date
US Nat'l of PCT/IL98/00435	HEREWITH		

Applicant/  
Patentee. **Benny PESACH**

Invention: **THREE DIMENSIONAL DEPTH ILLUSION DISPLAY**

I hereby declare that I am:

the owner of the small business concern identified below;  
 an official of the small business concern empowered to act on behalf of the concern identified below;

NAME OF CONCERN. Holomedia Technologies, Ltd.

ADDRESS OF CONCERN: 20 Hameretz Street, Petach-Tikva 49517, Israel

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in:

the specification filed herewith with title as listed above.  
 the application identified above.  
 the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the Inventor, who could not qualify as an independent Inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- no such person, concern or organization exists.
- each such person, concern or organization is listed below.

FULL NAME

---

 Individual Small Business Concern Nonprofit Organization

FULL NAME

---

 Individual Small Business Concern Nonprofit Organization

FULL NAME

---

 Individual Small Business Concern Nonprofit Organization

FULL NAME

---

 Individual Small Business Concern Nonprofit Organization

ADDRESS

---

 Individual Small Business Concern Nonprofit Organization

ADDRESS

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 Individual Small Business Concern Nonprofit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

Acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING:

Zevik NURI

TITLE OF PERSON SIGNING

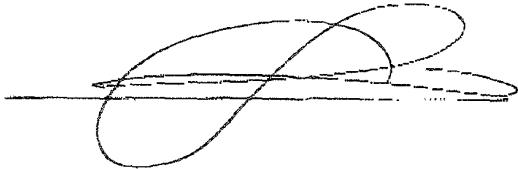
General Manager

OTHER THAN OWNER:

ADDRESS OF PERSON SIGNING:

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## THREE DIMENSIONAL DEPTH ILLUSION DISPLAY

### FIELD OF THE INVENTION

This invention relates to the field of optical display devices with three dimensional depth effects.

### BACKGROUND OF THE INVENTION

If two planes are displaced by a small distance from each other, the front plane being transparent, each plane being printed with a two dimensional pattern, the front one of opaque strips, and the rear one with a complementary pattern which can include shapes of objects, or graphic designs, motion of one plane with respect to the other produces an appearance of motion in the resulting visual field. This relative motion can be produced either by physically moving one plane relative to the other, or by motion of the observer as he passes in front of the planes. The front plane acts as a moving shutter, exposing or concealing different parts of the rear plane as the position of the front plane changes relative to the line of sight from the viewer's eye to the rear plane. The result is a visual field which changes with the viewer's position, or with the relative position of the planes if their motion is used for the effect. These changes can be used to create an illusion of motion in the viewer's mind.

This moving shutter effect has been widely used for many decades for creating an illusion of motion or change in the appearance of two dimensional display devices, such as those used for street advertising signs, billboards, point-of-sale promotion, or in artistic display pieces, and much prior art is known. Such devices in various forms have been shown in U.S. Patents No. 829,492 (Spiegel), 911,561 (Spiegel), 2,374,371 (Morch), 3,484,969 (Newland), 3,918,185 (Hasala), 4,263,737 (Simon) and others.

More recently, similar devices have been proposed, but using the well known Moire effect to create the illusion of movement in the resulting patterns. In the Moire effect devices, both planes are printed with periodic patterns with a small spatial

frequency difference between the front and rear patterns. The combination of these two periodical patterns creates a third 'beat' pattern whose appearance depends on the difference in spatial frequency between the two patterns. For clarification, it should be pointed out that in the familiar demonstration of the Moire effect, it appears as though the effect is obtained using two line patterns at a slight angle, each with identical line frequency. Even in this case, there is nevertheless a frequency difference, generated by the fact that the two patterns are held at a slight angle, such that the frequency component of the one which overlaps with the second is the line frequency multiplied by the cosine of the angle between them.

As in the previous case, the Moire pattern is given the appearance of motion by varying the position of the front screening plane with respect to the line of sight between the observer and the other plane, either by moving one of the planes or by movement of the observer. Examples of such moving Moire pattern devices are shown in U.S. Patents No. 4,789,573 (Jenkinson), 4,975,620 (Tacquard et. al.), 4,300,068 (Baird et. al.), 3,643,361 (Eaves), 3,811,213 (Eaves), 3,827,797 (Eaves) and 4,586,798 (Eaves).

The principal physical difference between these two groups of devices is that in the first, non-Moire group, the screening plate acts as a moving shutter that exposes a different image according to the relative position between the planes, while in the Moire effect devices, it is the combination of two periodical patterns which creates a moving pattern when the relative position between the planes is changed. Furthermore, in the first group, any image can be used but only discontinuous changes produced, whereas in the second, Moire pattern group, the images are limited to those which consist of segmented combinations of periodic patterns. On the other hand, the Moire pattern motion can be made continuous.

Methods for creating depth illusion, without the need to use any special viewing aids such as spectacles, can also be divided into these two groups. The familiar lenslet array method, wherein different images are seen in different viewing directions, is similar to the moving shutter principle, except that for depth illusion, the different exposed images are simply views of a three dimensional object or scene from different directions. Use of the lenslet array effect imposes strict limitations on the ranges and angles from which the depth illusion can be perceived.

The second group, of continuously moving Moire patterns, can also be used to create an illusion of depth. In U.S. Patent No. 3,643,361, and as further developed in

U.S. Patent No. 3,811,213, Eaves uses this effect to create an illusion of depth in a display device. The main part of Eaves' patent deals with the creation of an illusion of motion, as previously described. In his embodiment, one constant frequency dot patterned transparency is moved in relation to another constant frequency dot patterned transparency to produce the motion illusion. Eaves also points out, however, that depth illusion is observed when the dot patterns of the two transparencies have a small frequency difference between them, and are spaced apart by some small distance.

He explains that the depth illusion is created by means of two effects. Firstly, the parallax effect, also known as retinal disparity, which arises from the slight difference between the view of the Moire pattern perceived by each of the viewer's eyes. The viewer's mental processes use this difference to visualize the depth, as in regular stereoscopic vision. This mechanism is further emphasized by means of the second effect, called motion parallax, whereby movements of the head cause the Moire pattern of the object to move in relation to its background. The viewer's mental perception of depth also makes use of this relative movement effect, and can thereby distinguish even fine depth differences. When both the dot frequencies and the transparency spacing are optimally chosen, a depth illusion is created. In the above mentioned patents, Eaves shows how a two dimensional object can be made to appear suspended in space or standing out in front of a more distant background plane. The two dimensional object appears to be in the real plane of the display apparatus and the background appears as a more distant plane. Eaves also pointed out, in col. 15, line 10 of U.S. Patent 3,811,213, that the closer the frequency of the two patterns, the greater the retinal disparity and motion parallax, and hence the greater the depth illusion.

However, when an attempt is made to create a full three dimensional visualization of an object or scene using Eaves' method to create an appearance of several levels of depth behind the real display plane, a serious perception problem arises. Even if the image is built up of only a few layers with different depths, the result is visually confusing, and it is difficult to perceive the correct depth order of the planes.

The problem exists because of a combination of effects arising from the nature of Moire patterns. As mentioned by Eaves, the closer the frequency of the two patterns, the greater the depth illusion. However, a basic property of all Moire patterns is that the closer the frequency of the two patterns, the wider the resulting stripes. This can be understood by considering the way in which the two varying periodic patterns interact

by analogy with wave theory. When two waves with close frequencies interfere, a third wave is created with a frequency equal to the difference in frequency between the two original waves. This third wave is known as a 'beat' wave. The closer the frequency of the two waves, the smaller the frequency of the 'beat' wave, or the Moire pattern in the analogy. Stated alternatively, the closer the frequency of the two patterns, the wider the period of the stripes of the observed Moire pattern. This explains the source of the effect which causes the above mentioned problem with Eaves' method.

The combination of these two effects implies that the further behind the real surface plane an object or a plane is made to appear, the larger the resulting period of the Moire pattern. However, this result is in direct contradiction to a third visual perception mechanism of depth in the human mind, which was not mentioned and probably not noticed by Eaves, related to the apparent size of distant objects. This mechanism is that if two views are compared, each with a periodical line pattern of different period, the one with the larger period appears to be closer. This effect arises from the tendency of the mind's visual perception to assume that all lines are equally spaced in reality, and that the observed differences in period are caused by differences in depth. This effect is routinely used in graphic arts to enhance the impression of visual depth in pictures of three dimensional objects.

Therefore, when Eaves' method is used to create three dimensional objects made up of several planes at different depths behind the real plane, these two depth perception mechanisms contradict each other in the observer's mind, and the result is confusing, unclear and unrealistic. Since Eaves, in the above mentioned patent, showed an embodiment with only one background plane at a one specific depth, this visual contradiction was not apparent and therefore not noticed.

Another problem with the prior art presented in the Eaves patents is that the use of dots for providing the motion effect in two orthogonal directions results in low contrast of the Moire pattern.

A further drawback of the prior art shown by Eaves is that it proposes the use of patterns made up of two dimensional regions of constant frequency. This only allows the formation of discrete planes in an image with different apparent depths, but it does not enable the formation of true three dimensional continuous images, such as spheres, cylinders or bottles.

To the best of applicant's knowledge, no prior art exists which suggests or shows how to create continuous three dimensional images, which images show correct perspective and mutual movement of their constituent parts as the observer moves in front of the images. The creation of such images, to show realistic articles such as spheres, bottles, cans, etc. would be of great importance in the field of large format advertising for such products, in the form of signs, billboards, point of purchase promotions, or in other fields where a spectacular, eye catching, three dimensional image is needed. Small format advertising and graphic effects, such as are used on credit cards, phone cards, mail advertising material and the like, would also benefit greatly from such an invention.

## SUMMARY OF THE INVENTION

The present invention seeks to provide an apparatus and method for producing continuous three dimensional images possessing an illusion of depth by means of the Moire effect.

The Moire image produced by a preferred embodiment of the present invention is formed by overlaying, one on top of the other, two predetermined patterns of nearly vertical lines, at least one of whose line period or spatial frequency varies slowly. This combination of patterns creates a third image pattern whose appearance depends on the difference between the two patterns. Since the two planes in this apparatus are displaced from each other by a small distance, the overlap of the two substantially periodic patterns, and hence also the Moire image, depends on the position of the observer.

The depth illusion is created using the parallax effect, which arises from the difference between the picture that each of the eyes sees. This mechanism is reinforced by the effects of movements of the observer's head, an effect known as motion parallax. When the observer's head is moved, the observed Moire pattern moves relative to the real plane, so that it looks as though it is at a different depth. Therefore, the relation between the speed of movement of the observer's head and the speed of movement of the Moire pattern supports and strengthens the depth illusion created by the parallax effect, and thus helps the observer to distinguish even fine depth differences.

The contradiction mentioned above between the two competing depth perception mechanisms is solved in the present invention by creating the depth illusion using two

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planes, at least one of which has a variable frequency pattern, instead of using planes with constant frequency patterns, as suggested by Eaves. By this means, both the Moire pattern period and the apparent depth can be controlled independently, so that the contradiction can be avoided.

The method mentioned in the Eaves patents for increasing the illusion of depth behind the real plane is to decrease the frequency difference between the two patterns. An alternative method, which is used in the present invention to avoid the visual perceptive contradiction which arises using Eaves' method, is by increasing the absolute frequency of both patterns, keeping the frequency difference constant. As a result, for the same speed of movement of the viewer's observation point, the Moire pattern seems to move more quickly than that with a lower frequency, since, for the same movement of the observer, a greater absolute number of periods of the front pattern move relative to the rear pattern. The Moire pattern thus appears more distant. In the same way, the difference in appearance of the image between the viewer's two eyes is also increased accordingly, so that the parallax effect is also increased.

These two ways of increasing the depth can be combined, making it possible to control both the Moire pattern period and the depth by varying both the average frequency and the frequency difference of the patterns. By using slowly varying periodic patterns in either one or both of the front and rear planes, instead of the constant frequency pattern suggested by the Eaves method, the resulting Moire pattern period or strip width can be controlled independently from the apparent depth or the relative speed of movement of the Moire pattern. Thus, the contradiction apparent in the prior art between the two depth perception mechanisms can be resolved. As a result, even continuous three dimensional surfaces and objects can be created.

Furthermore, the use of two slowly varying periodical patterns enables more flexibility in the creation of three dimensional objects such as spheres, boxes, cans, bottles or faces. Since the period and speed of movement of the Moire pattern can be controlled at every point of the display, the pattern can be changed continuously over the display so that it appears to flow over the required continuous three dimensional surface. The pattern period or width can be controlled to express not only the relative apparent size-depth perception mechanism, but also the simple geometric perspective effect, which causes features of a tilted surface viewed from the front to narrow with the cosine of the tilt angle. This effect further enhances the feeling of perspective and depth

generated in this object, and if, for instance, the object has a round shape, its image appears to rotate as the observer moves sideways. Other graphical depth enhancement features, such as shading or special lighting effects can also be added to the image.

The creation of three dimensional objects or surface illusions can also be achieved by varying the distance between the surfaces imprinted with the periodic patterns. Thus a Moire pattern with three dimensional depth illusion can be created even using two plates or surfaces with shapes of constant spatial frequency printed on them, provided that the distance of separation of the surfaces is varied according to the effect required. This embodiment of the present invention is, however, more difficult to manufacture than the embodiment described above using flat surfaces with patterns of varying period.

The use of almost vertical lines in a preferred embodiment of the present invention, rather than the two dimensional array of dots used in Eaves' invention, limits the motion and depth effects produced to the horizontal direction. Since the major parallax effects take place in a horizontal direction, because of the horizontal arrangement of the eyes, this limitation itself is not a serious drawback. The use of vertical lines does however enable another significant advantage, since the use of lines causes the image contrast to be increased many fold, thus making the device more useful commercially.

There is thus provided in accordance with a preferred embodiment of the present invention, at least two surfaces, one of which is a substantially transparent sheet displaying a predetermined nearly vertical periodic first line pattern, and the other of which displays a black and white or a colored periodic second line pattern, with a slightly different period from the first pattern. The period of either one or both of the line patterns has a slow variation in the horizontal direction. The patterns are separated by a small distance of at least several times the period of the line patterns, such that the combination of both patterns produces a Moire pattern which changes with the observer's position in front of the first surface, and creates an illusion of continuous depth in the image, without the need for any special viewing aids, such as special spectacles.

There is further provided in accordance with another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, including a first surface, the first surface being substantially transparent and at least part

of which displays a first pattern of features of periodic nature with a substantially constant period, and a second surface, at least part of which displays a second pattern of features of periodic nature with a substantially constant period, and wherein the first surface is intermediate an observer and the second surface, the period of the second pattern differs incrementally from the period of the first pattern, the period of at least part of at least one of the patterns has a slow variation, and the first and second surfaces are spaced apart by a distance larger than the period of either of the first and second patterns, and wherein the incremental difference in the periods of the patterns, the spacing between the first and second surfaces, and the variation in the period of the at least part of at least one of the patterns are selected such that the interaction of the first and second patterns produces a Moire image exhibiting continuous three-dimensional visual effects.

In accordance with yet another preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above and wherein the lines are arranged in a substantially vertical direction and the variation of the period of at least part of at least one of the patterns takes place in a substantially horizontal direction.

In accordance with another preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above and wherein sections of the features or lines are shifted horizontally with respect to each other in different horizontal bands of the patterns, to produce images with varying vertical detail.

In accordance with still further preferred embodiments of the present invention, there is provided a device for displaying an image with an illusion of depth as described above and which exhibits realistic three dimensional effects either by means of the static parallax effect resulting from the mutual displacement of the views of the image as seen by each of an observer's two eyes, or by means of the motion parallax effect resulting from changes in the appearance of the image with change in the position of the viewer.

There is further provided in accordance with yet another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and wherein the feature size of the image changes with the apparent depth in such a way as to comply either with the mind's perception that distant objects appear to have narrower details and close objects have wider details, or with the

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geometric perspective effects that features on a tilted surface appear narrower than those on a flat surface by approximately the cosine of the tilt angle.

There is still further provided in accordance with another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and wherein the brightness of features of the image changes with the apparent depth in such a way as to comply with the shading effect or any other desired lighting effect.

In accordance with yet another preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above, and which can be viewed by the observer's naked eye without the need for any special viewing aids such as special spectacles.

In accordance with a further preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above, and wherein the second surface is either transparent, translucent or opaque.

There is further provided in accordance with yet another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and wherein the spacing of the surfaces is between 5 and 100 times the pattern period.

There is still further provided in accordance with another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and wherein the surfaces are printed with patterns of the same or different color, or wherein the second surface background color is different from that of any of the other printed patterns.

In accordance with a further preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above, and wherein either:

- (a) the two surfaces are disposed on the opposite sides of a transparent plate, or
- (b) the first surface is disposed on one side of a transparent plate, and the second surface is a thin printed layer disposed close to the second side of the plate, or
- (c) both first and second surfaces are thin printed layers disposed on both sides of a plate, or
- (d) the first surface is disposed on one side of a transparent plate, the second surface is disposed on one side of another plate, the plates being disposed at a fixed

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distance from each other such that the surfaces are spaced from each other by a predetermined distance

In accordance with yet another preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth as described above, and wherein at least one of the first and second surfaces is constructed of wire netting, or is thin and flexible such that it can be rolled on a cylinder.

There is further provided in accordance with yet another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and wherein the device is illuminated from the front, the rear or from at least one of its edges.

There is still further provided in accordance with yet another preferred embodiment of the present invention, a device for displaying an image with an illusion of depth, as described above, and which is constructed and operative for large area use such as in billboards, or for small area use such as in credit cards.

In accordance with yet another preferred embodiment of the present invention, there is provided a device for displaying an image with an illusion of depth including first and second surfaces, the first one of which is transparent, each having at least part of its surface printed with a predetermined pattern of substantially periodic features, the surfaces being spaced apart by a distance considerably larger than the period of the features, and the spacing of the surfaces being varied in a predetermined manner such that the interaction of the two patterns produces a Moire image exhibiting continuous three dimensional visual effects when viewed from the first surface side of the device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings, in which:

Fig. 1 shows a schematic drawing of the pattern with slowly horizontally varying frequency used on the front surface to produce the images shown in Figs. 3 and 4.

Fig. 2 shows a schematic drawing of the pattern with slowly horizontally varying frequency used on the rear surface to produce the images shown in Figs. 3 and 4.

Fig. 3 shows a schematic example of a Moire pattern having three dimensional visual effects, of half of a vertically striped sphere protruding from a background plane,

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obtained using apparatus constructed and operated according to a preferred implementation of the present invention, and as viewed by an observer's left eye.

Fig. 4 shows a schematic example of a Moire pattern having three dimensional visual effects, of half of the vertically striped sphere protruding from a background plane, as shown in Fig. 3, but viewed from a horizontally slightly moved observation point, such as would be seen by the right eye.

Fig. 5 is a view of a flat checkered pattern to be produced by the Moire effect.

Fig. 6 shows the appearance of either the front or rear surface patterns required to produce the checkered Moire pattern shown in Fig. 5.

Fig. 7 illustrates schematically the different object patterns used for the contrast analysis of the resulting Moire pattern for the case with one or two colors.

Fig. 8 illustrates schematically the different object patterns used for the contrast analysis of the resulting Moire pattern for the case with two or three colors.

Fig. 9 is a schematic view of a device constructed and operated according to a preferred embodiment of the present invention, consisting of a single thin transparent plate with front and rear surfaces, each printed with their respective pattern with slowly horizontally varying frequency, and separated by a small predefined distance, being the thickness of the plate.

Fig. 10 is a view of a double layer device. One layer is a transparent plate with one side fully or partially printed with a pattern with slowly varying frequency. The other layer is made of a thin material which is not necessarily transparent, printed with the second pattern with slowly varying frequency.

Fig. 11 is a view of a triple layer device. The two thin layers are located close to the opposite sides of the thick transparent plate. The thin layer closer to the observer is transparent and fully or partially printed with a pattern with slowly varying frequency. The other layer is made of a thin material, not necessarily transparent, and is printed with the second pattern with slowly varying frequency.

Fig. 12 is a view of a double plate device, showing the two thick plates.

Fig. 13 is a view of a billboard type of display device, constructed and operated according to a preferred embodiment of the present invention, using a fixed net as the front surface medium.

Fig. 14 is a view of a billboard display device as described in Fig. 13, but using a rolling net or thin layer for the front surface medium.

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## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1 and Fig. 2 which show the patterns on the front and rear surfaces of a preferred embodiment of the present invention. These two surfaces are separated by a small distance. These two patterns are combined to produce a Moire pattern when observed from the front side. The front surface preferably comprises a substantially transparent sheet imprinted with vertical or nearly vertical line patterns with slowly varying period in the horizontal direction, as shown in Fig. 1. The rear surface is imprinted with a color or black and white horizontally slowly varying periodic pattern, such as in Fig. 2. The front surface must be substantially transparent to allow the light reflected from or transmitted through the rear surface to pass through the front surface and combine in the observer's eye with that from the rear surface. Unless the apparatus is back lit, the rear surface need not be transparent. The patterns printed on the two surfaces are constructed and operative in such a way that their combination produces the desired Moire pattern, with an illusion of depth in the observer's mind.

When used as the front and rear patterns respectively in an apparatus constructed and operated according to a preferred embodiment of the present invention, the patterns shown in Fig. 1 and Fig. 2 create a three dimensional visual image of half a vertically striped sphere protruding from a background plane.

Figs. 1 and 2 constitute a real working pair of patterns, which can be used to demonstrate the present invention, once a transparent copy of the front plane has been made. The plane spacing has to be approximately 5 cm. The features of the patterns in these two figures are much enlarged from those of a device which would give detailed images in a hand-held model of this size. For such a model, the real periods would be too small to be seen by the naked eye. The patterns in Fig. 1 and Fig. 2 are drawn to an exaggerated scale in order to clarify the principle through which the effect of the present invention is produced, and in order to show the detailed features of the patterns for the purpose of this description. This is the reason why, in order to view the resulting image using these two patterns, a plane separation of 5 cm has to be used, as compared with a spacing of the order of a 0.5 to 5mm for an image of this size to realistic scale. The level and scale of detail shown in Figs. 1 and 2 would be typical for a large area display sign, suitable for viewing at a distance of several meters or more.

Fig. 3 shows schematically the Moire pattern resulting from combination of Fig. 1 and Fig. 2, as seen from a single observation point representing the left eye of the observer. Fig. 4 shows schematically the Moire pattern as seen from an observation point moved slightly horizontally, representing the right eye of the observer. The combination of these two images in the observer's mind creates the three dimensional visual effect of half of a vertically striped sphere protruding from a background plane, with both the hemisphere and the background plane appearing to be behind the real display plane.

As is seen in Fig. 3, at the center of the sphere 31, the Moire pattern period, or in other words, the width of the Moire pattern strips, is larger than the width of the strips at the edges of the sphere 32 and 33, or in the background plane 34. Thus, according to the mind's size-perception mechanism, the center of the sphere looks closer to the observer. The width of the Moire pattern strips at each point of the sphere surface is determined by the frequency difference at the corresponding points of the two patterns with slowly varying frequency shown in Figs. 1 and 2. It is seen in Figs. 1 and 2 respectively, that the period of the two horizontally slowly varying periodic patterns at the centers 11, 21 of the sphere is larger than the period at the edges of the sphere 12, 13, 22, 23, or than the period of the background periodic function 14, 24. Consequently, the resulting Moire pattern at the center of the sphere 31 as seen in Fig. 3 by the left eye, is displaced by only 1/4 of a strip width from the position of the image of the center of the sphere 41 seen in Fig. 4 by the right eye, while the background pattern 34 seen by the left eye moves by a whole strip width compared to that of the right eye 44. The relative background movement of one complete strip can be clearly seen in Figs. 3 and 4 in the pattern stripes next to the left or right vertical borders. The quarter strip movement at the center of the sphere can also be discerned in Figs. 3 and 4, but with more difficulty. As a result of the above movements, the background plane 34 seems to the eyes to move more than the center of the sphere 31. This, according to the parallax mechanism, causes the background to appear located further behind the real picture plane than the center of the sphere.

Furthermore, the width of the Moire pattern strips at the center of the sphere 31 is larger than the width of the strips of the background 34, as previously explained. Thus, both according to the relative size depth perception mechanism, and according to the parallax mechanism, the sphere center looks closer to the observer. Consequently, in

accordance with this preferred embodiment of the present invention, not only do these two perception mechanisms not contradict each other, but they even reinforce each other to improve the depth illusion of the three dimensional continuous objects. The creation of clear, impressive, and in particular, unambiguous illusions of three dimensional continuous objects is the major advantage of the present invention.

The observed depth of each point of the display depends on the local periodicity of the front pattern, the local periodicity of the rear pattern, the distance between them and the observer location. By continuously changing the period of the front and rear patterns, it is possible to create continuous three dimensional images, such as the sphere shown in Fig. 3 and Fig. 4. In addition to the above mentioned effect, relating to the width of the Moire pattern strips, the front and rear patterns are constructed and operative such that the strips of the resultant Moire pattern image appear to cover the surface of the sphere with the correct perspective of a three dimensional image. Because they are viewed at a steep angle, the geometric perspective effect causes the strips at the sides of the sphere to appear narrower than their real width by the cosine of the angle between the viewing direction and the surface normal. As a result, when an observer moves horizontally, he sees a three dimensional sphere, whose strips "flow" over the sphere surface, continuously changing position, shape and width in such a way as to give the illusion that the sphere is rotating in his direction of movement, and show the correct perspective changes expected from a real life sphere. This effect enhances the three dimensional illusion and the visual impression of the display.

To illustrate the way in which a complex image including areas with discretely varying vertical detail, is constructed from the base front and rear surface patterns, the construction of a checkered pattern is now considered. Fig. 5 shows such a pattern. It is useful in understanding how such a pattern is constructed by considering it to be an amendment to the stripes shown in the background in Fig. 3 and Fig. 4. Each vertical stripe is split up into alternating black 45 and white 46 sections, with adjacent stripe patterns out of phase with each other.

This effect is achieved by inverting the printed and non-printed areas in either the front or rear surface pattern, in horizontal strips whose height is equal to the height of the desired square height. Fig. 6 shows the pattern required on either the front or the rear surface in order to produce the checkered Moire pattern schematically shown in Fig. 5. The  $180^\circ$  phase changes between successive horizontal strips 47, 48, which produce

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the contrast changes in the vertical direction are clearly visible. The width of the checkered squares is determined, as with the stripes in the background, by the period of the Moire pattern, which is determined by the frequency difference between the front and rear patterns. In general, Moire patterns with such discretely variable vertical detail are produced from front and back patterns with sections of their periodic features shifted horizontally with respect to each other in different horizontal bands.

Fig. 5 shows a checkered pattern at a fixed depth level. As with the striped sphere shown in Figs. 3 and 4, it is possible to add depth illusion to the checkered pattern by selecting the absolute frequency of the two patterns and the frequency difference, as in any Moire pattern created by the present invention. The size of the squares of the checkered pattern can be chosen to improve the depth illusion by using the relative size depth-perception mechanism, and thus by creating the illusion that the checkered pattern flows over a continuous three dimensional surface with movement of the observer's position, as before. Similar periodical patterns can be created by similar means.

It should be pointed out that the terms "horizontally slowly varying frequency pattern" or "horizontally almost periodic pattern" refer only to those parts of the patterns which make up continuous sections of objects to be Moire imaged in the device. At the edges of objects, such as at the boundary between the sphere and the background, large discrete changes of the pattern period may be used. The changes of the pattern in the vertical direction control the vertical dependence of the observed Moire pattern, as demonstrated in the checkered pattern example.

The desired period of the pattern with horizontally slowly varying frequency is sufficiently small that it is not discerned by the observer when the apparatus is viewed from the optimal distance. At this distance, only the Moire pattern of the combination of the two patterns is seen by the observer. Therefore, the changes in the Moire pattern required to produce the features of the image itself, both vertically and horizontally, are naturally on a much larger scale than the horizontal period of the pattern, as mentioned in the previous paragraph.

The required difference in period between the front and rear patterns of varying period is in the range of about  $\pm 20\%$ . In order to obtain good depth illusion, the period of the front and rear patterns should be in the range of about 5-100 times smaller than

the distance between the two planes. Patterns with larger ratios also give the desired effect, but are more difficult to produce.

In the present invention, the optimal range over which the depth effect is observed is large compared with other depth illusion displays, such as lenslet array displays, that can be viewed without any aids, such as special spectacles. Furthermore, in contrast to the lenslet array method, the observed depth in a Moire effect display looks almost the same from any distance of observation, because of the difference in the physical principle of the illusion. The upper limit of the observation distance is determined by the ability to physically discern the Moire pattern. This limit can be set at very large distances by making the period of the Moire patterns wide.

The depth effect also can be seen from a wide range of angles, at least  $\pm 45^\circ$  from a vertical plane perpendicular to the display plane, although the viewed depth changes somewhat according to the cosine of the angle of the observer relative to the perpendicular to the display plane. These properties make the depth illusion method according to the present invention very suited for street advertising boards, since it can be clearly seen from a wide area. The present invention can be implemented in devices with a wide range of sizes. It can be used for small sized graphic effects on items such as credit cards, where it could replace the hologram as the security device, on postcards, small signs, point of purchase promotional signs, bus stations signs and right up to giant billboards.

In general the frequency of the pattern in the front plane, as shown in Fig. 1, is lower than the frequency of the corresponding area in the rear plane, as shown in Fig. 2. This causes the observed sphere and background to appear behind the real display plane, since with this order, the Moire pattern moves in the same direction as the observation point relative to the display. As shown in the Eaves patents, if the frequency of the pattern in the front plane, Fig. 1, is higher than the frequency of the rear plane Fig. 2, the resulting Moire pattern moves in the opposite direction to the movement of the observation point relative to the display. The Moire pattern therefore looks as though it is in front of the display apparatus. However, in this case, too, the use of the above described preferred embodiment of the present invention enables the width of the Moire pattern strips to be controlled separately from their apparent depth, by using two varying periodic patterns of appropriate form.

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In the prior art invention of Eaves, the use of dots to produce the front and back patterns enables the Moire pattern to move in both horizontal and vertical directions. However, since the human eyes are separated horizontally, and it is the parallax effect which provides the major depth perception effects, it is possible to sacrifice the vertical motion of the Moire pattern, and as is shown hereinunder, significantly to increase the contrast of the Moire effect. This is done in a preferred embodiment of the present invention by using a pattern of nearly vertical lines instead of dots. The contrast of the resulting Moire pattern is consequently increased by up to six times, compared with the prior art dot patterns, and the overall depth clarity is significantly increased.

In the same way, it is possible to achieve the same increase in image contrast by use of a pattern of substantially horizontal lines, with the slowly varying change in pattern period taking place in a vertical direction. Such a preferred embodiment would be useful for small devices, where the major part of the depth illusion could be obtained by movements of the head up and down, rather than by static parallax effects.

Fig. 7 and Fig. 8 demonstrate differences between the dot pattern devices of the prior art, and the line patterns proposed by preferred embodiments of the present invention. Referring to Fig. 7, box 110 is a typical cut out section of the depth illusion apparatus where dots are used for the creation of the Moire effect, as per the prior art shown by Eaves. Plane 111 is the front plane, which is the one closer to the observer, and plane 112 is the rear plane. According to Eaves' prior art, both planes are transparent and printed with opaque dots of the same color. Fig. 7 shows schematically the four possible extreme cases of overlap 113 - 116 for the two planes 111 and 112 when viewed by the observer. Image 113 shows the observer's view when the device is viewed from a direction exactly perpendicular to the planes 111, 112, such that the dots of the two planes overlap exactly. Image 114 is an illustration of the view seen when the observation point is moved slightly horizontally.

The image contrast change of the Moire image is defined as the percentage partial change in opacity of the total image as a fraction of the maximal possible change. A contrast factor of 1 would mean that the resulting Moire pattern changes from full transparency to full opacity. Thus for the difference between 113 and 114, the contrast change is  $1/4$ , if we approximate the dots by squares of the same dimension, in order to simplify the calculations. This approximation is continued for the rest of the calculations, without losing the validity of the conclusion. If the dots were not

approximated by squares, the exact contrast change would have to be multiplied by  $\pi/4$  to obtain an exact result.

View 115 shows the mode seen if the observation point is moved vertically from 113 by a small amount, or alternatively, if the pattern of the dots on one of the planes 111 or 112 is moved vertically by the same amount. View 116 is the result of a horizontal movement from the situation of view 115. This time the partial change of the opacity between the two possible horizontal modes is zero because the dots in 115 do not overlap as in 113, and the transmission is unchanged. To obtain the overall contrast change of this depth illusion device, the average of the two cases of 113-114 and 115-116 has to be taken, since they both have the same probability of occurring, since the vertical height of the observation point is unknown to the designer. The resulting contrast change is therefore the average of 1/4 and 0, namely 1/8.

The contrast improvement provided by the present invention can be divided into two steps. Firstly, changing the pattern on one of the planes from dots to vertical or near vertical lines, as shown in device 120, doubles the Moire effect contrast, which in itself significantly improves the depth clarity. Secondly, by using vertical or nearly vertical lines in the second plane too, as shown in device 130, the contrast is again doubled.

The box 120 shows a typical section of a depth illusion apparatus with one plane, in this case the front one 121, printed with a line pattern, and the other 122, with dots. Both planes are printed with the same color as before. 123-126 shows schematically the four extreme cases of overlap, analogous to modes 113-116 for the case with the dots only. The partial change of the printed area to the background area in going from 123 to 124 is 1/4 of the total area. In order to cover the case of an opaque or translucent rear plane, with its own specific background color, the definition of the contrast has been expanded to be the ratio of the partial change between the printed color and the background color as a fraction of the maximum possible change. A unity contrast change implies a Moire pattern change from full printed color to full background color. 125 and 126 show the other two possible modes that arise when the observation point is moved slightly vertically. The difference between 125 and 126 is again a horizontal movement of the viewing point. This time the partial change is the same as the change between 123 to 124, so the average contrast between transparency and opacity or between the background color to the printed color of the resulting Moire

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pattern is  $(1/4+1/4)/2=1/4$ . As previously mentioned, this result is alone double the contrast obtained using two planes with dots.

The second improvement is shown in device 130. Here both of the planes, 131 and 132, are printed with a vertical or nearly vertical horizontal line pattern. As in the previous cases, the front plane must be transparent but the rear plane does not have to be so, and both of the planes are printed with the same color. For this case, vertical movement of the observation point does not change the observed pattern at all. There are thus only two modes of overlap of the two planes 131 and 132, as shown in views 133 and 134. The partial change of the printed area to the background area is  $1/2$  of the total maximal possible change, so the contrast change is  $1/2$ . This result is double the contrast change obtained in case 120, and four times that of case 110.

The use of colors for the Moire pattern is another improvement of the present invention. It is possible to obtain at least the same contrast improvement over the case of the dots when three different colors are used in the different planes. Fig. 8 shows the same contrast analysis as Fig. 7, but using different colors for the two planes. The three cases are for both planes with dots 210, one plane with dots and one with stripes 220, and both planes with stripes 230. For this calculation, it is assumed that the front plane 211, 221 or 231 is transparent and printed with a black pattern. The rear plane 212, 222 or 232 is transparent or translucent or opaque with one background color and a pattern of dots or lines of a different color. With observer movement, the Moire pattern switches color between the two rear plane colors and for this case, the contrast change is defined as the partial change between the two colors of the Moire pattern from the maximum possible change. Thus, since the Moire pattern consists of two different colors, the black areas from the front plane dots should not be counted in the contrast definition.

Returning to Fig. 8, for the case of two planes both printed with dots case 210, views 213-216 shows schematically the four possible modes of overlap of the two planes 211 and 212. 213 and 214 show the images of 210 seen from two horizontally displaced observation points. The partial change of the color of the combination of the two planes is  $1/4$  of the total area if the dots are approximated by squares of the same dimension. The total colored area, excluding the area of the black dots, is in this case  $3/4$  of the total area. Thus, according to the three color definition of the contrast change, it is  $(1/4) / (3/4)$ , which equals  $1/3$ . 215 and 216 shows the other two possible views of

210 seen from two horizontally displaced observation points vertically displaced from those of views 213 and 214. This time the partial change of the color between the two possible horizontal modes is zero because the dots in 215 do not overlap. The overall contrast change of the two dots planes case is obtained by averaging the two cases of 213-214 and 215-216 as before, giving a contrast change of  $(1/3+0)/2=1/6$ .

In the second case the front plane is changed from dots to vertical lines or nearly vertical lines, as shown in 220. The same colors and contrast are used as in the previous case. 223-226 shows schematically the four possible modes of overlapping for the two planes 221 and 222. 223 and 224 shows the two horizontal modes seen when the observation point is moved horizontal. The partial change of the background color to the printed color of the combination of the two planes is  $1/4$  of the total area. The total colored area in this case is  $1/2$  of the total area, so that according to the three color definition of the contrast change, it is  $(1/4) / (1/2) = 1/2$ . 225 and 226 show the other two possible horizontally displaced images seen from an observation point moved a little vertically. This time the partial change is the same as the change between 223 to 224, so the average contrast between the printed color to the background color of the resulting Moire pattern is  $(1/2+1/2)/2=1/2$ . This result is three times the contrast change obtained in the two dot planes case shown in 210.

The third case is shown in 230. Here both of the planes, 231 and 232, are printed with a vertical or nearly vertical line pattern, with the same colors as in cases 210 and 220. This time vertical movement of the observation point doesn't change the observed pattern at all. Thus only two modes of overlap, 233 and 234 need be considered. The partial change of the printed color to the background color of the combination of the two planes is  $1/2$  of the total area. The total colored area in this case is  $1/2$  of the total area, as in 220. Thus, according to the three color definition of the contrast change, it is given by  $(1/2)/(1/2)=1$ . So the contrast change between the colors of the Moire pattern resulting from a horizontal movement is 1. This result is six times better than that obtained with two dot planes, as shown in case 210.

If we use the same contrast change definition as that previously used for cases 110, 120 and 130, which compares the partial change of color to the total area, the improvement obtained by using vertical line or nearly vertical line patterns rather than a dot pattern is still a factor of four. The second definition of the contrast, as used in cases 210, 220 and 230, is more suited to the case of two rear plane colors and a black front

pattern. If the front plane pattern is not black, but printed with a third color, the analysis shown here can be extended using the same principles by anyone skilled in the art, and shows that the fourfold improvement in contrast still exists.

The above embodiments of the present invention all use vertical lines in order to take advantage of the increased contrast and visibility afforded by this configuration. It should be noted though, that when contrast is not of primary importance, but the presence of some three dimensional visual effects also in the vertical direction is of importance, further embodiments of the present invention can be proposed using dots instead of lines. In such an embodiment, the dots must be arranged in arrays with spatial frequencies which are slowly varying in both directions according to a predetermined pattern, in order to obtain realistic, non-confusing depth effects, as per the method proposed in this invention.

Fig. 9 to Fig. 14 show examples of devices useful for implementing the present invention. Fig. 9, shows the simplest embodiment, using a single transparent plate 50, printed on both sides. The plate can be made of any transparent material such as glass, PVC, polycarbonate, etc. The side closer to the observer, called the front side 51, is partly or wholly printed with a semitransparent pattern of horizontally slowly varying frequency vertical or near vertical lines. Semi-transparent in this context is used to mean that the area between the opaque lines is transparent while the line itself is as opaque as possible. This pattern can fully or partially fill the front side of the plate. It can consist of one color or more, and some of the area can be fully opaque or transparent.

The other side of the plate, the rear side 52, is printed with another horizontal pattern of vertical or near vertical lines with slowly varying frequency, which, like the first side, fully or partially fills the plate area. This pattern does not have to be semitransparent, although it can have transparent or opaque areas too. However, there should be a significant visual difference in color, brightness or transparency, between the printed horizontally almost periodic pattern and the background of this pattern, in order to obtain a Moire pattern with good contrast. This printed horizontally almost periodic pattern can be of one color or more. It should be understood that, as stated previously, Fig. 9 can also be implemented with the spatial frequency of the pattern on only one of the two sides of the plate being slowly varying. This applies also to the other embodiments shown in the following Figs. 10 to 14.

The plate thickness can be in the range from 0.5mm to 10cm, or even thicker if required. One possible implementation is a POP sign or bus station poster, which require a plate area of 1 to 2m<sup>2</sup>. Using conventional printing methods, such as screen printing, the pattern period can be as small as 0.25 mm or even smaller, and with a plate thickness of 2mm, a good sense of depth illusion can be achieved. Such a plate can fit into existing poster fittings without any changes. Such posters are usually back lit, which is also good lighting for the depth illusion device.

Fig. 10 shows a second possible embodiment of the present invention using a transparent plate 53 printed on one side and a thin printed layer 54 attached or otherwise positioned close to the other side. The plate can be made of any transparent material. The side closer to the observer, the front side 55, is printed with a semitransparent pattern of horizontally almost periodic, nearly vertical lines, as before, fully or partially filling the front side of the plate. As before it can consist of one color or more, and some of the area can be fully opaque or transparent. The thin layer 54, on which is printed the second horizontally almost periodic pattern of vertical or near vertical lines, fully or partially filling the image area, is juxtaposed or attached to the other side of the plate, the rear side. The thin layer can be transparent, and made of a material such as PVC or any other transparent polymer, or can be an opaque material such as paper, which is easier to print by, for example, offset, laser or ink jet printing. The thin layer can also be translucent to increase the brightness and the visibility of the image. The use of the thin layers simplifies the printing process, in that instead of printing both patterns on the plate, only one pattern need be printed on the plate. The pattern can be of one color or more, as before.

The preferred embodiment shown in Fig. 11 further simplifies the printing process. Here both patterns are printed on a thin layer. The two thin layers are attached or otherwise located close to both sides of a plate 56. The thin layer 57 on the side closer to the observer, the front side, is transparent. It is printed with a semitransparent pattern of horizontally almost periodic nearly vertical lines, as before, fully or partially filling the front side of the plate. As before it can consist of one color or more and some of its area too can be fully opaque or transparent. The other thin layer 58, which is printed with the second horizontally almost periodic pattern fully or partially filling the image area, is attached to the other side of the plate, the rear side. This thin layer can be transparent, opaque or translucent, as before.

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Fig. 12 shows a preferred embodiment of the present invention comprising two plates. The plate closer to the observer, the front plate 59, is transparent and can be made of any transparent material as before. This plate is printed with a semitransparent pattern of horizontally almost periodic, nearly vertical lines, as before, fully or partially filling the front side of the plate. As before, it can consist of one color or more and it can have some of the area fully opaque or transparent as well. As in the embodiment shown in Fig. 10, this pattern too can be printed on a thin transparent layer attached to the front plate to simplify the printing process. The second plate, the rear plate 60, is printed with the second horizontally almost periodic pattern of near vertical lines, fully or partially filling the image area. This plate can be transparent or translucent if it is back-lit, or opaque if it is front-lit. As for the front plate, a thin layer printed with the second pattern can be attached to the rear plate instead of printing directly on it, to simplify the printing process. The rear thin layer can be transparent, opaque or translucent to gain image visibility and sharpness. The two plates are disposed in a fixed position relative to each other. The advantage of this device is that it can be used for large signs, where a large separation between the two patterns is required. Separating the thick plate into two separate plates makes the construction lighter and cheaper.

Figs. 13 and 14 shows two additional embodiments of the present invention especially suitable for use in large size billboards. All the implementations previously shown in Figs. 9 to 12 can be used to create the depth illusion effect for billboards. However because of the large area of these signs, the use of a net with orthogonal wires provides a cheaper and simpler method. The vertical strips of the net are used to create the Moire effect, while the horizontal strips are used solely for supporting the vertical strips.

Fig. 13 shows an embodiment where the front net 70 is held in a rigid frame 71. Fig. 14 shows an embodiment where the net 75, in this illustration the front net, is rolled onto a rotating cylinder 76. The advantage of the rolled net is the ease with which the net can be mounted or removed when changing signs, or when changing the billboard from regular use to use with the depth illusion effect, and back. Instead of using a net for the front plane, a thin flexible transparent foil printed with a horizontally almost periodic nearly vertical line pattern can be used to increase the range of possible three dimensional images.

The net has additional advantages because of the strength of the wires and their better resistance to strong winds. The rear plane 77 can be the regular billboard plate, which can be opaque and front lit, or translucent and back lit. The rear pattern is printed by one of the usual methods used for billboards, and is attached to the billboard plane. Illumination of the billboard can be done by using conventional methods, such as back lighting, or by using strong halogen projectors 78 located above or below the billboard on the inner side of the front plane, i.e. the side closer to the rear plane, as seen in the cut-away section of Fig. 13. This arrangement avoids casting a shadow of the front net on the rear plane, which would cause an additional unwanted Moire pattern.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of various features described hereinabove as well as variations and modifications thereto which would occur to a person of skill in the art upon reading the above description and which are not in the prior art.

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## CLAIMS

1 claim:

1. A device for displaying an image with an illusion of depth, comprising:
  - a first surface, said first surface being substantially transparent and at least part of said first surface displaying a first pattern of features of periodic nature with a substantially constant period; and
    - a second surface, at least part of said second surface displaying a second pattern of features of periodic nature with a substantially constant period;
      - wherein said first surface is intermediate an observer and said second surface,
        - wherein said period of said second pattern differs incrementally from the period of said first pattern;
        - wherein said period of at least part of at least one of said patterns has a slow variation;
        - wherein said first and second surfaces are spaced apart by a distance larger than the period of either of said first and second patterns; and
        - wherein said incremental difference in the periods of the patterns, said spacing between the first and second surfaces, and said variation in the period of said at least part of at least one of said patterns are selected such that the interaction of said first and second patterns produces a Moire image exhibiting continuous three-dimensional visual effects.
  2. A device for displaying an image with an illusion of depth according to claim 1 and wherein said features comprise a series of lines.
  3. A device for displaying an image with an illusion of depth according to any of the previous claims and wherein sections of said features are shifted horizontally with respect to each other in different horizontal bands of said patterns, to produce images with varying vertical detail.
  4. A device for displaying an image with an illusion of depth according to claim 1 or claim 2, wherein said features are arranged in a substantially vertical direction, and

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said variation of the period of at least part of at least one of said patterns takes place in a substantially horizontal direction.

5. A device for displaying an image with an illusion of depth according to claim 1 and wherein the views of said image as seen by each of an observer's two eyes are mutually displaced in such a way as to exhibit realistic three dimensional effects by means of the static parallax effect.

6. A device for displaying an image with an illusion of depth according to claim 1 and wherein the appearance of said image changes with change in the position of a viewer in such a way as to exhibit realistic three dimensional effects by means of the motion parallax effect.

7. A device for displaying an image with an illusion of depth according to claim 1 and wherein the feature size of said image changes with the apparent depth in such a way as to comply with the mind's perception that distant objects appear to have narrower details and close objects have wider details.

8. A device for displaying an image with an illusion of depth according to claim 1 and wherein the feature size of said image changes with the apparent depth in such a way as to comply with the geometric perspective effects that features on a tilted surface appear narrower than those on a flat surface by approximately the cosine of the tilt angle.

9. A device for displaying an image with an illusion of depth according to claim 1 and wherein the brightness of features of said image changes with the apparent depth in such a way as to comply with the shading effect or any other desired lighting effect.

10. A device for displaying an image with an illusion of depth according to claim 1 and which can be viewed by the observer's naked eye without the need for any special viewing aids such as special spectacles.

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11. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said second surface is transparent.

12. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said second surface is translucent.

13. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said second surface is opaque.

14. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said spacing of said surfaces is between 5 and 100 times said pattern period.

15. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein both of said surfaces are printed with patterns of the same color.

16. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein both of said surfaces are printed with patterns of different color.

17. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said second surface background color is different from that of any of the other said printed patterns.

18. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said two surfaces are disposed on the opposite sides of a transparent plate.

19. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said first surface is disposed on one side of a transparent plate, and said second surface is a thin printed layer disposed close to the second side of said plate.

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20. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein both first and second said surfaces are thin printed layers disposed on both sides of a plate.
21. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said first surface is disposed on one side of a transparent plate, said second surface is disposed on one side of another plate, said plates being disposed at a fixed distance from each other such that said surfaces are spaced from each other by a predetermined distance
22. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein at least one of said first and second surfaces is constructed of wire netting.
23. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein at least one of said first and second surfaces is thin and flexible such that it can be rolled on a cylinder.
24. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said device is illuminated from the rear.
25. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said device is illuminated from the front.
26. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said device is illuminated from at least one of its edges.
27. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said device is constructed and operative for large area use such as in billboards.

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28. A device for displaying an image with an illusion of depth according to any one of claims 1 or 5 - 10 and wherein said device is constructed and operative for small area use such as in credit cards.

29. A device for displaying an image with an illusion of depth, comprising:  
first and second surfaces, first one of which is transparent, each having at least part of its surface printed with a predetermined pattern of substantially periodic features;  
said surfaces being spaced apart by a distance considerably larger than the period of said features; and

the spacing of said surfaces being varied in a predetermined manner such that the interaction of said two patterns produces a Moire image exhibiting continuous three dimensional visual effects when viewed from said first surface side of the device.

DRAFTING DRAWING

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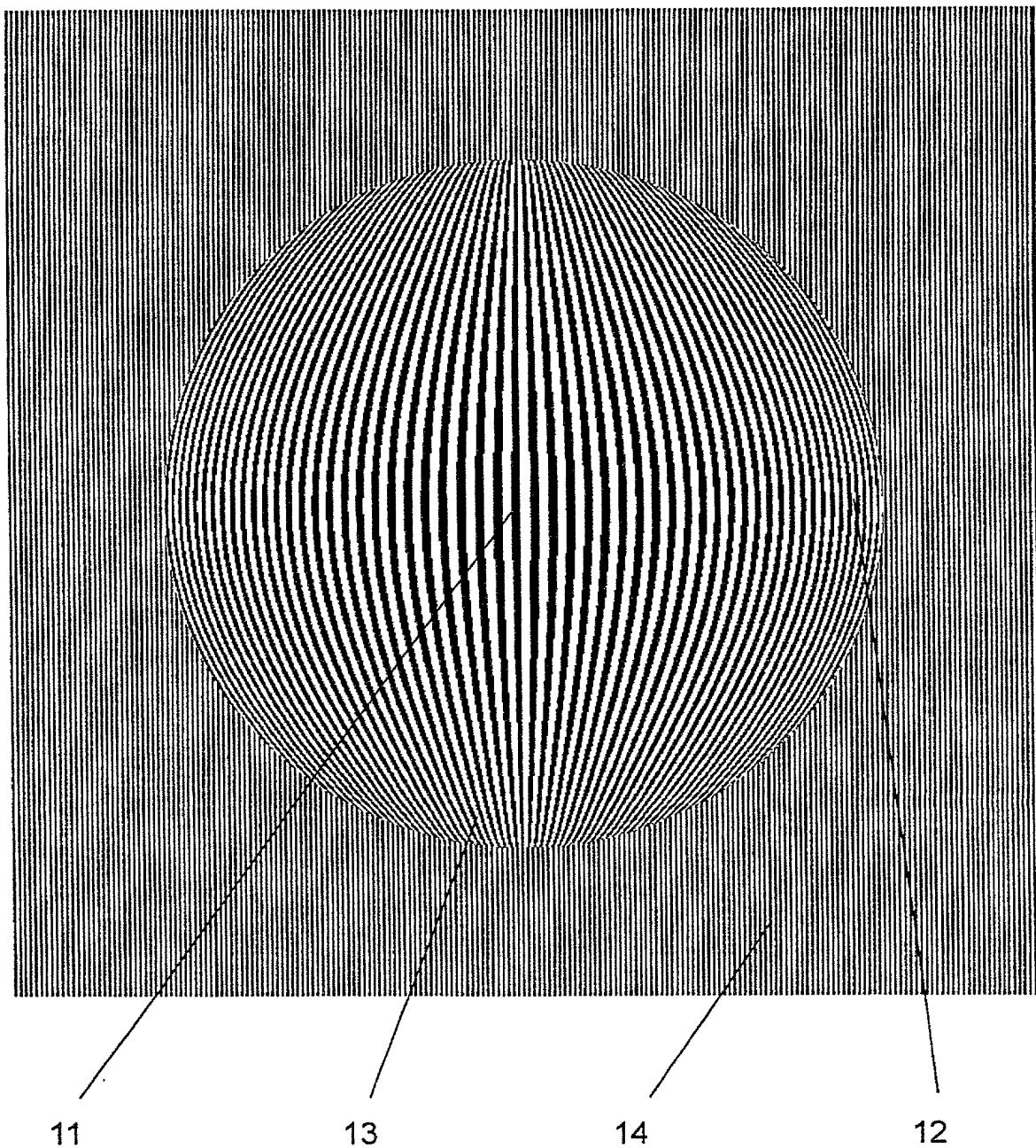


FIG. 1

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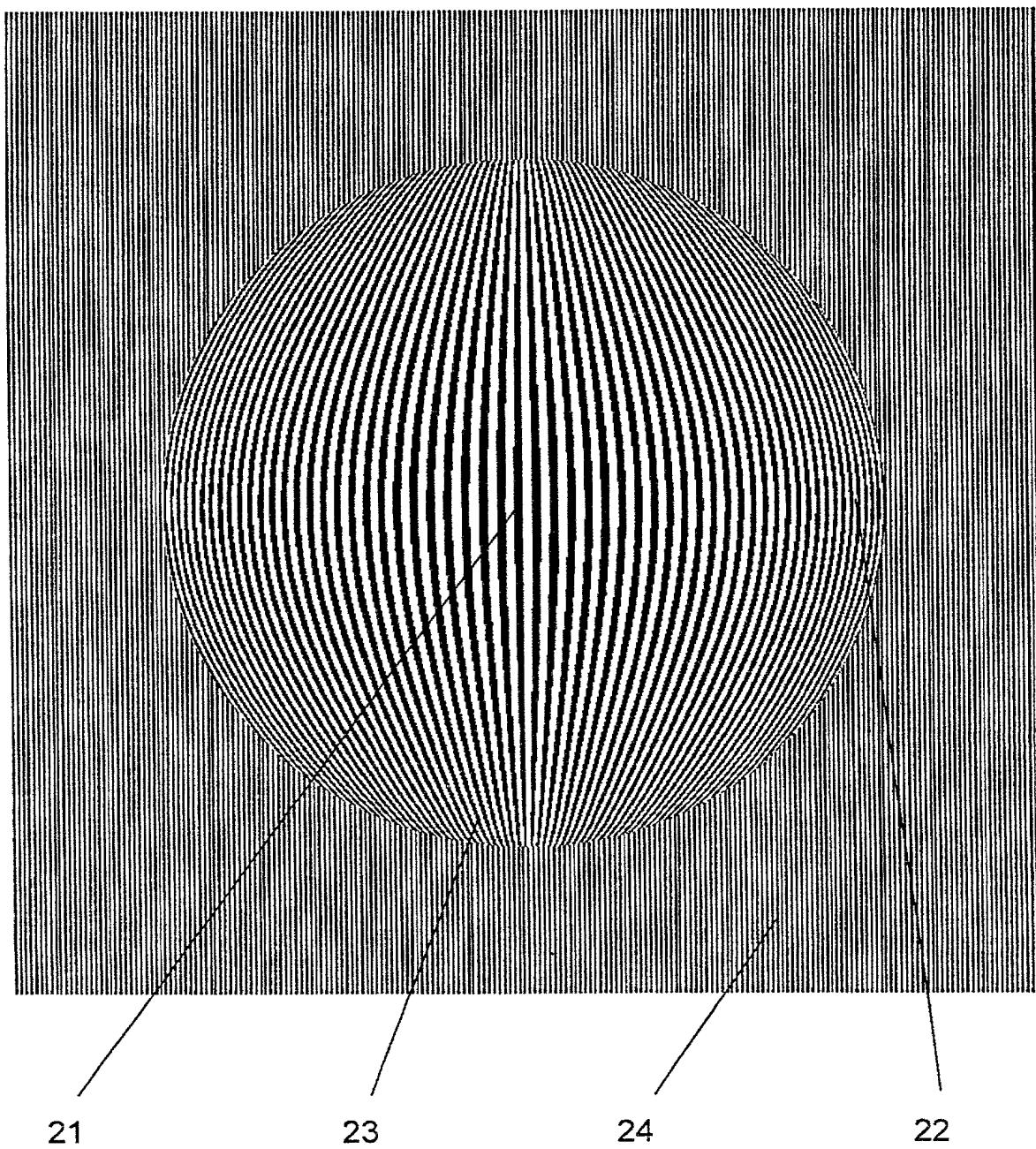


FIG. 2

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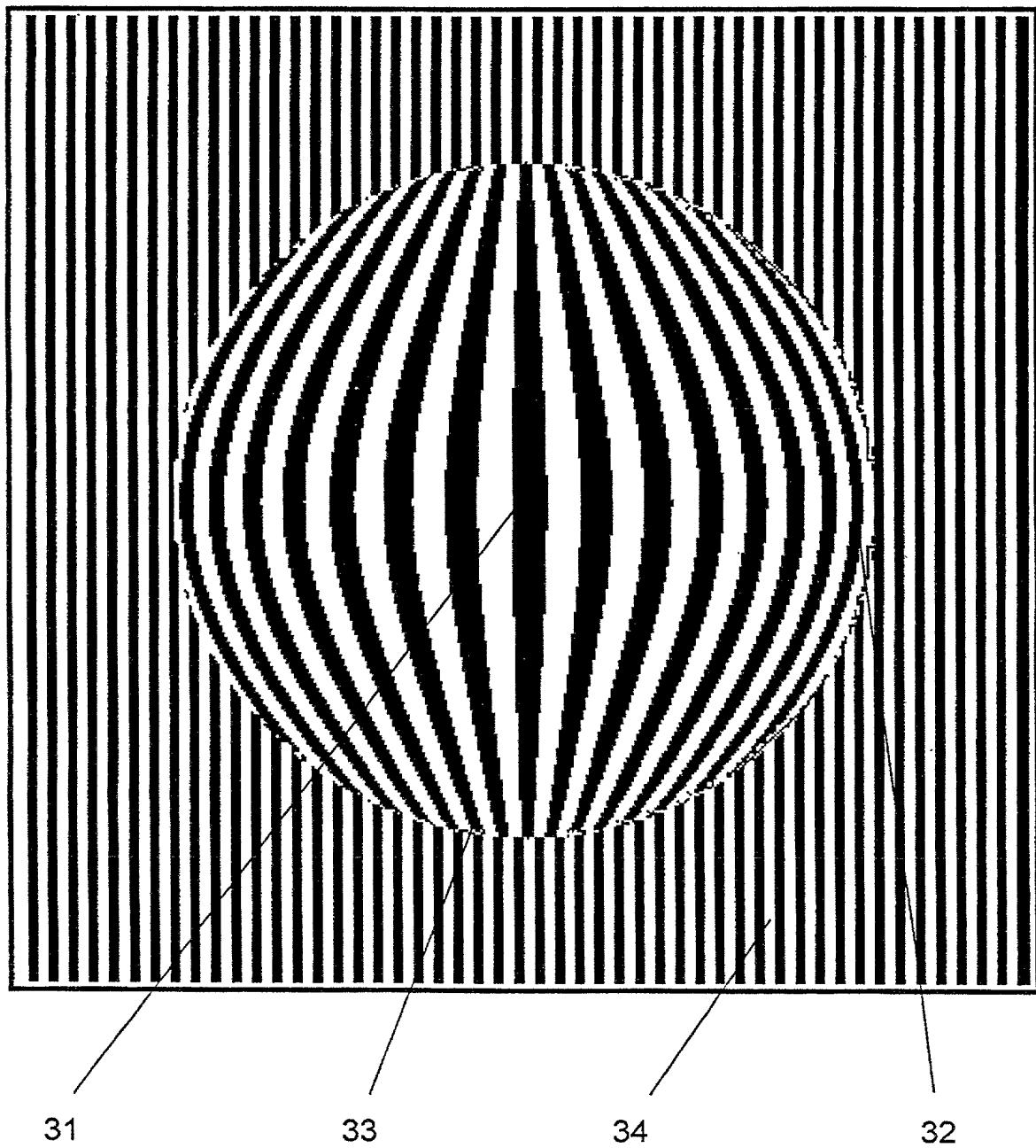


FIG. 3

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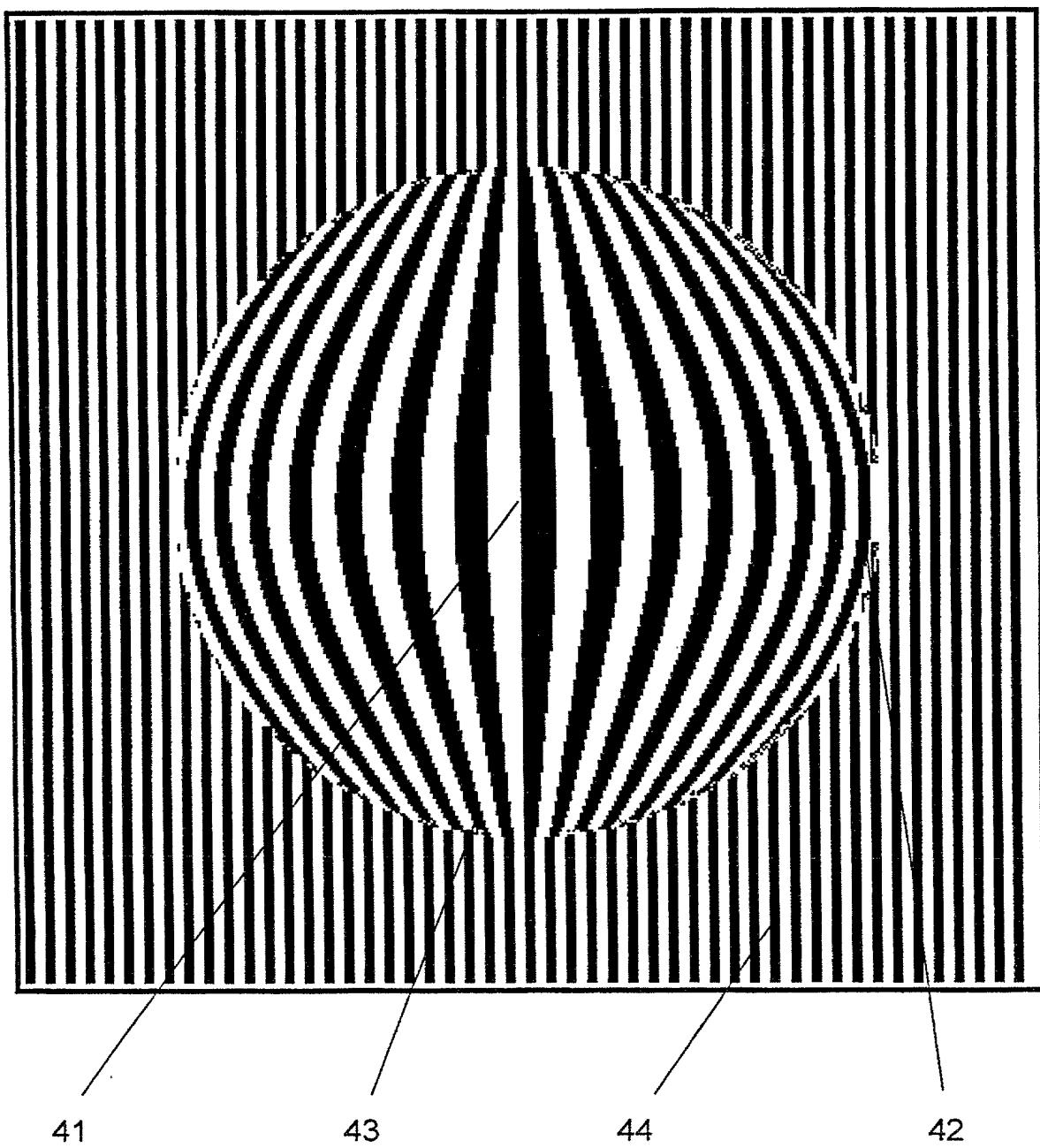


FIG. 4

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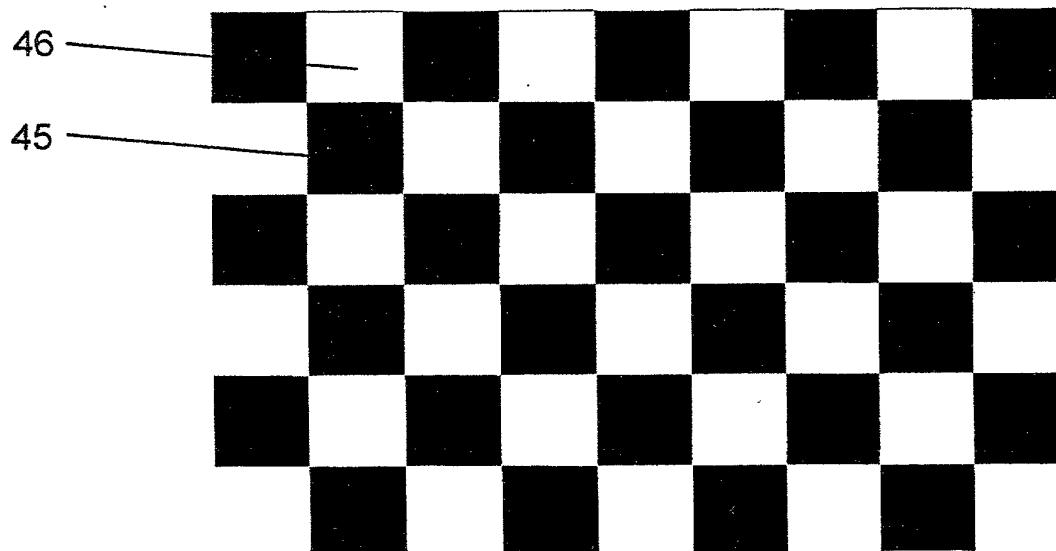


FIG. 5

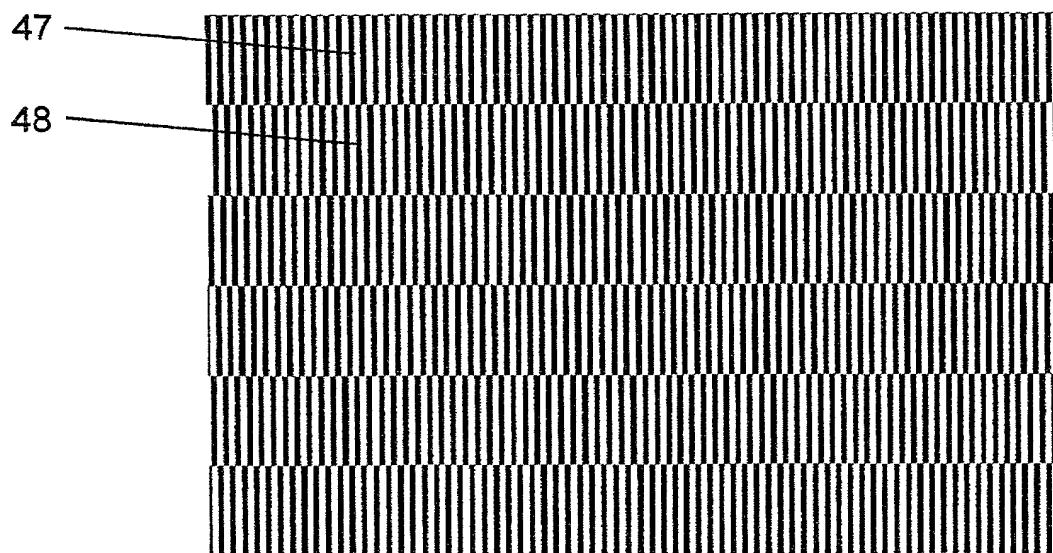


FIG. 6

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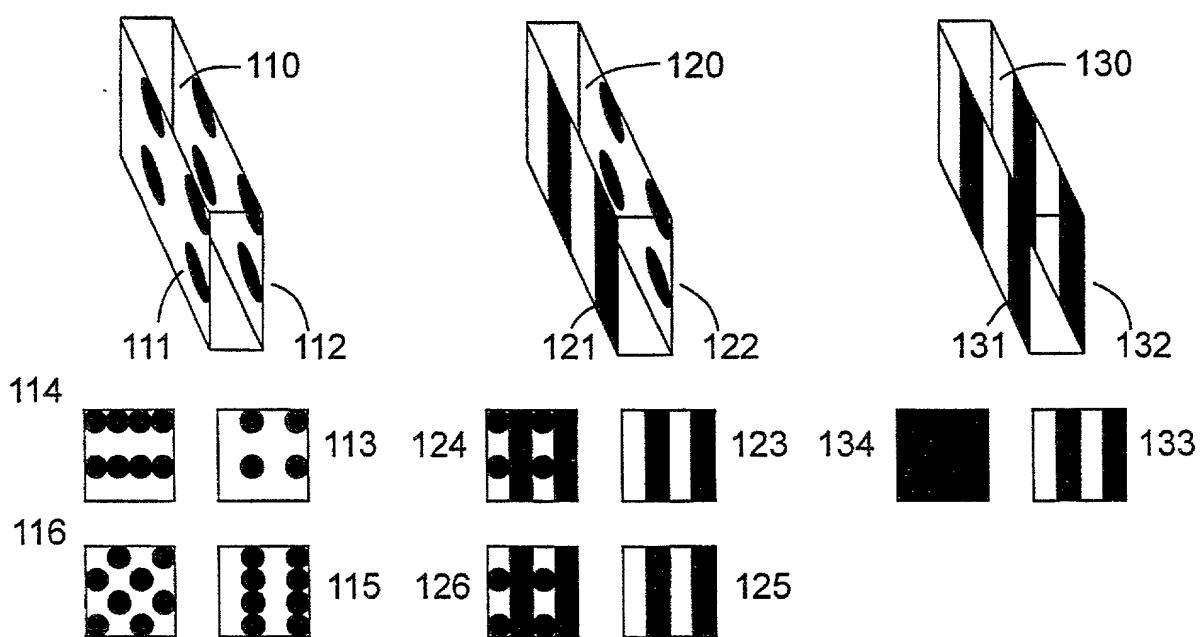


FIG. 7

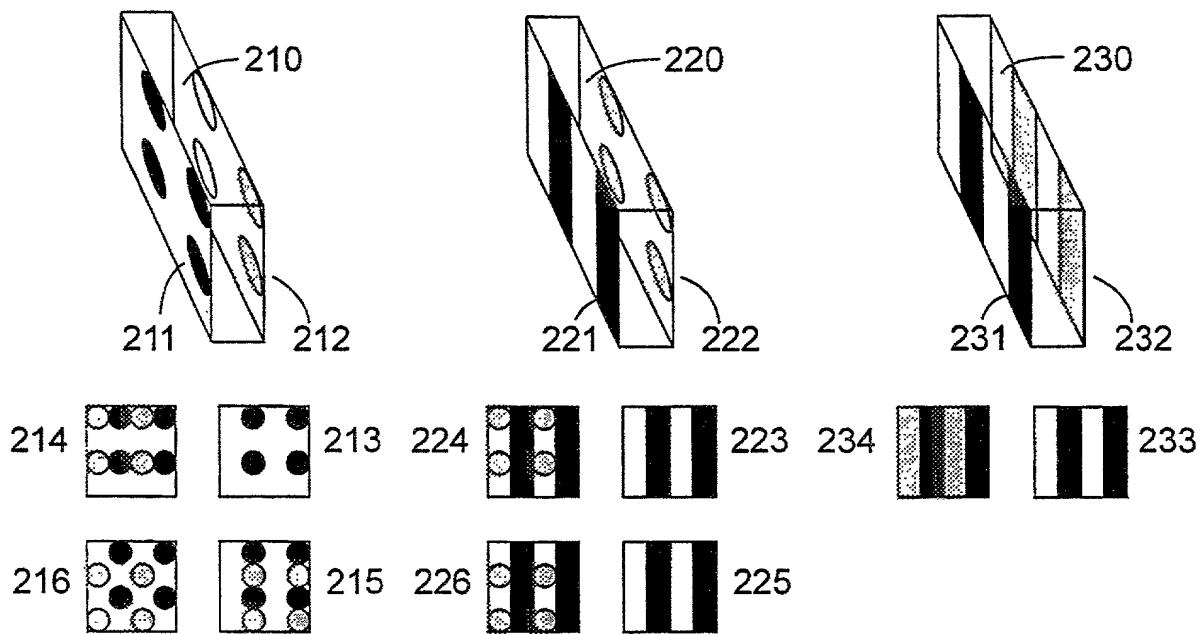


FIG. 8

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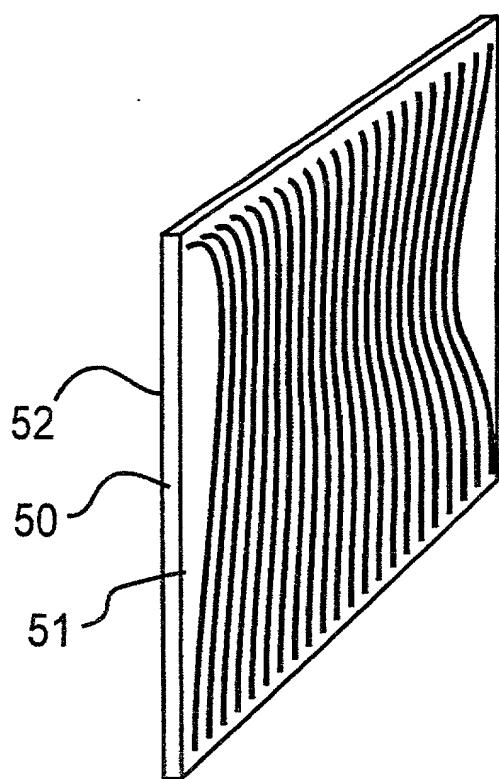


FIG. 9

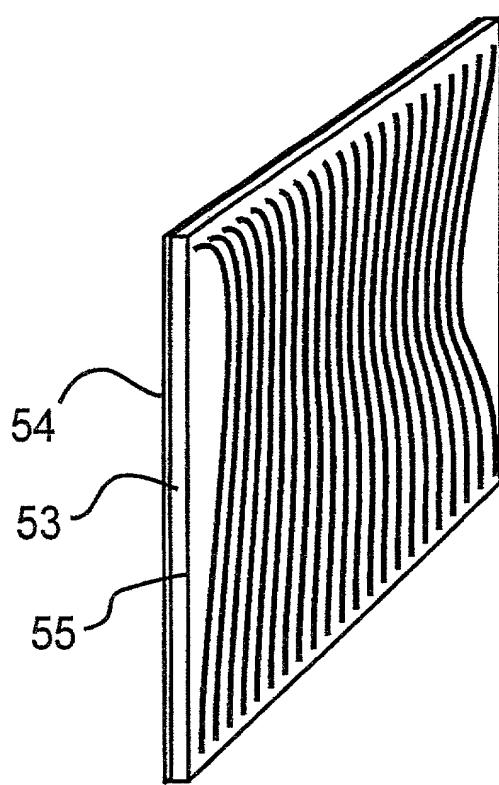


FIG. 10

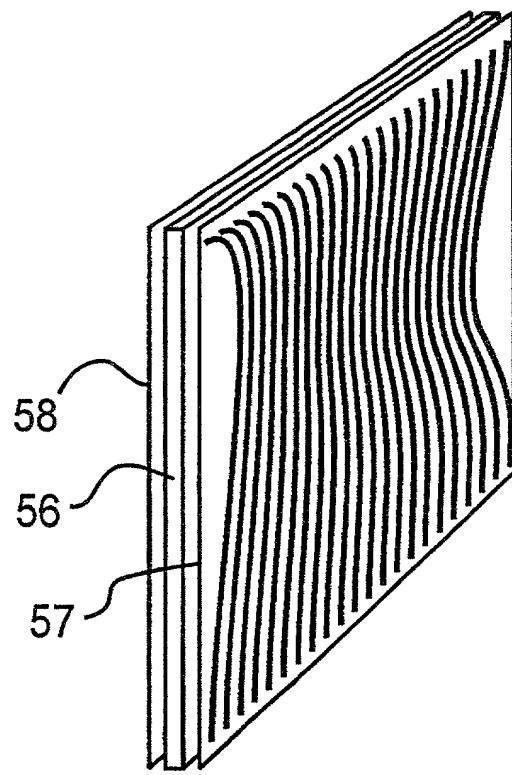


FIG. 11

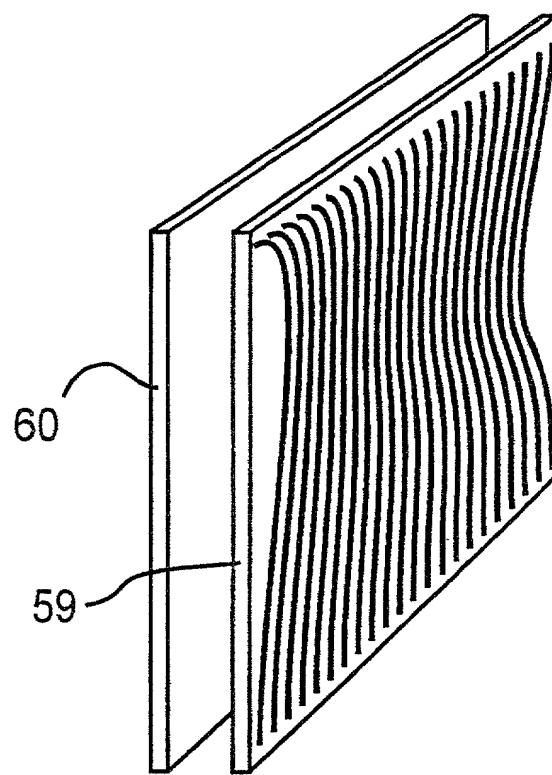


FIG. 12

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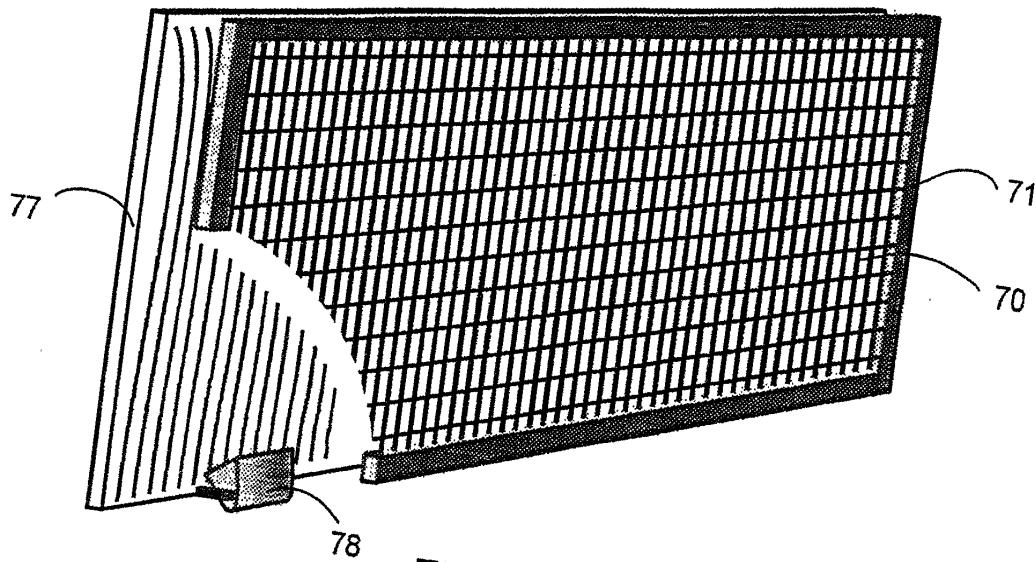


FIG. 13

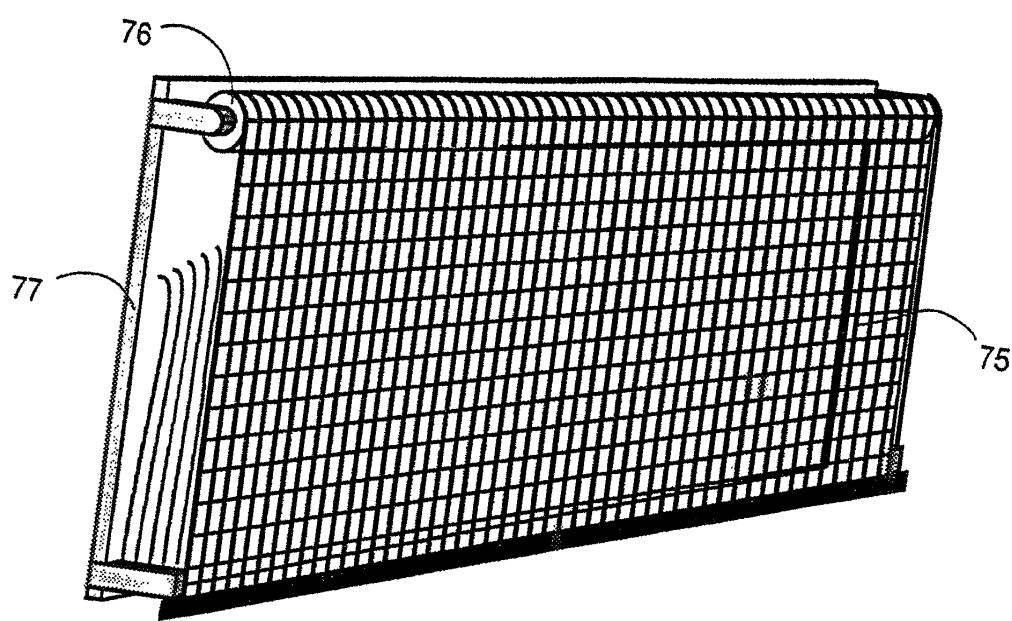
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FIG. 14

Docket No.  
179/01406

# Declaration and Power of Attorney For Patent Application

## English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

### THREE DIMENSIONAL DEPTH ILLUSION DISPLAY

the specification of which

(check one)

is attached hereto.

was filed on September 9, 1998 as United States Application No. or PCT International Application Number PCT/IL98/00435

and was amended on October 26, 1999

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

### Prior Foreign Application(s)

### Priority Not Claimed

<u>121760</u> (Number)	<u>Israel</u> (Country)	<u>14 September 1997</u> (Day/Month/Year Filed)	<input type="checkbox"/>
<u>                  </u> (Number)	<u>                  </u> (Country)	<u>                  </u> (Day/Month/Year Filed)	<input type="checkbox"/>
<u>                  </u> (Number)	<u>                  </u> (Country)	<u>                  </u> (Day/Month/Year Filed)	<input type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.) (Filing Date)

(Application Serial No.) (Filing Date)

(Application Serial No.) (Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.) (Filing Date) (Status)  
(patented, pending, abandoned)

(Application Serial No.) (Filing Date) (Status)  
(patented, pending, abandoned)

(Application Serial No.) (Filing Date) (Status)  
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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